No 393 — Read the following endorsement of the District Engineer, Presidency, dated 12th May 1875, No 700 —

From J N GRAINGER, Esq, General Superintendent of Public Works Stores and Workshops, to Captain R THOMPSON, R E, District Engineer, Presidency, dated Chepauk, 5th May 1875, No 169

With reference to G O, dated 14th April 1875, No 1,003, communicated with your endorsement, No 345, of the 16th idem, I have the honor to submit Mr Doderet's remarks on the several points noted in Colonel Strange's reply to the objections made to Messrs Cooke's levels

2 I can bear out Mr Doderet's remark that no complaints have been received in respect to these instruments I have received no complaints since I resumed charge of this department, and no report appears in the records of the office previously, and as regards the appreciation of Cooke's levels by the officers of the department, I think that the demand for these instruments in preference to others and the issue of 155 out of 157 received from England is sufficient evidence and a fair criterion to judge of their excellence I have always myself preferred a Cooke's level, and I believe that, if individual opinions were taken as regards their accuracy and efficiency, the balance would preponderate in favor of Cooke's

3 I beg to invite attention to Mr Doderet's suggested improvements contained in his remarks on points VII and VIII noted in Colonel Strange's memorandum

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From F DODERET, Esq, Government Mathematical Instrument Maker, Public Works Department, to J N GRAINGER, Esq, General Superintendent of Public Works Stores and Workshops, dated Chepauk, 5th May 1875

With reference to Colonel Strange's memorandum on the reported defects in Cooke and Sons' levelling instruments, recorded in G O, 14th April 1875, No 1,003, forwarded for my remarks, I beg to say that I have not heard or received any complaint respecting these levels I find that levelling instruments by Cooke and Sons have been in use in this Presidency since 1866, in which year sixty-four levelling instruments were received, and in 1871 ninety-three more were supplied by the Home Government, making in all 157, from which number 155 have been issued principally to the Public Works Department, and indenting officers invariably ask for Dumpy levels, showing thereby the estimation in which these instruments are held by them in preference to those by other makers I may here remark, as not foreign to the subject in hand, that the Mysore Department Public Works obtained forty of Cooke's levels from Messrs Orr and Sons, as they were not available for supply from the stores of the Department Public Works, and very recently the Chief Engineer, Mysore, preferred a 10-inch Dumpy by Cooke in the absence of 12 or 14-inch levels in store to a 20-inch Troughton's improved Y, although the latter could not be said to be by any means a bad instrument These are significant facts and go to show how highly Cooke's levels are appreciated, and lately one of the Assistants employed under Mr Clarke, Drainage Engineer, assured me personally that he never had a better instrument to work with

than that supplied to him from the Public Works Stores, and that he could not have done the work he did in so short a time with an inferior instrument Mr Clarke had seven of Cooke's levels issued for the use of his survey establishment I have no hesitation, therefore, in saying that Mr Clarke would be a good authority to give an opinion on the goodness or otherwise of the instruments in question In referring to Mr Clarke as an authority, I do not ignore the opinions of the officers of the Department Public Works who by their silence in respect to the efficiency of these instruments, their desire to have these instruments, when out of order, repaired and returned to them, while levelling instruments by Barren notably are returned for final deposit, and their wish at all times to have Cooke's Dumpy levels in preference to others, all these facts I submit are tacit admissions of the excellence of Cooke's levels, and speak volumes in favor of the instruments objected to by some of the professional officers in the sister Presidencies, and I unhesitatingly give it as my opinion that better instruments than Cooke's levels for neatness of finish, superior workmanship, accuracy and efficiency were never before supplied I admit that Simms' and Elliotts' are very good, but I must confess that Cooke's Dumpy levels have taken the lead since their introduction in this Presidency Highly pleased and satisfied as I am with Cooke's levels, there are some small defects which I would like to see remedied, and which I would very respectfully submit for the consideration of the Chief Engineer I allude to the clamping screw of the instrument referred to in paragraph VII of Colonel Strange's report, and which I will notice in its proper place

2 I will now enter *seriatim* on the points noticed by Colonel Strange —

I must here quote what I have already said in my report of the 24th October 1873, *viz*, that the improvements made by Messrs Cooke and Sons to levels are, 1st, the axis which in former levels rested on a base of about 1 inch diameter, giving friction of about $\frac{1}{16}$ to $\frac{3}{32}$ of an inch, are now made to revolve on a base of 2 or $2\frac{1}{2}$ inches diameter, the inner part of the base having been under turned so as to give the friction on the outer rim of the base of about $\frac{1}{8}$ of an inch, thus giving a larger base and not more friction than in the former axis It will be apparent that an instrument revolving on such a small base as $\frac{1}{4}$ inch and not being in perfect counterpoise could not be made perfectly steady, especially if the instrument has been for some time in use

I. Want of arrangement for correcting any error in the direction of the telescope to its vertical axis, or adjusting the horizontal axis perpendicular to the vertical

3 The levels made by Messrs Troughton and Simms and other makers have six screws below the support of the telescope, to enable the instrument to be adjusted for horizontal collination error This has always been considered a tedious adjustment, and by many ordinary surveyors it has not been understood for what purpose those screws are intended In Cooke's levels this has been omitted, as that adjustment is practically made correct, and the level is consequently independent of this adjustment The screw foot plate and triangular base plate is another improvement on the old parallel plate screws, as the instrument can be adjusted quicker and the screws are not so easily worn out The stand, although more cumbrous than the old pattern, is infinitely more steady and trustworthy, and does not get so easily out of order

4 It is my belief that this alludes to definition of the telescope which depends on achromatism of object glass, centricity of the glasses and absence of all impurities, as well as having the telescope tube darkened I have very carefully examined telescopes of several levels, both of Cooke's, Troughton and Simms', Elliott Brothers', Street, Baker, and Barrow The power of definition and magnifying power have varied no doubt owing in some to chromatism and eccentricity The telescopes of Cooke's and Troughton and Simms' are about equal (I mean of level telescopes of the last supply received), but by comparing telescopes of a very old supply with those lately received, I find that the former are not equal in power of definition to the latter One instance of this is given above, where the Chief Engineer,

II Power of glasses are found to be inferior to Troughton and Simms' They are not sufficiently powerful, and in unfavorable weather found to be hazy in most cases

Mysore, after comparing a 20-inch Y Troughton and Simms' with a 10-inch Dumpy by Cooke, preferred the latter instrument

5 I consider the arrangement of the adjusting screws for level and collination perfect I must observe, however, that the screws are often screwed so much home as to cause the spring between the screw and the socket to lose its elasticity or break I would strongly recommend that this mode of adjustment be discontinued, and the one adopted which the levelling instruments had when first received in this country in 1866, as I have altered many according to the latter arrangement

III —Adjustment of diaphragm by means of spiral spring and screw has not stood the test of wear and tear while it is affected by temperature

6 But for one drawback I would prefer this method to that adopted by other makers in fastening the object glasses Both means of securing the object glass in the cell have their benefits and drawbacks, but of the two methods I am of opinion that that of Cooke's is the best The drawback of the object glasses fastened into their cells by a screwed ring are,—1*st*, although each glass is marked with notches to indicate their relative surfaces, yet they have been frequently received by me put together quite promiscuously, no notice having been taken of the notches when doing so, 2*ndly*, taking into consideration that some of the object glasses are triplets, it can easily be imagined in how many different wrong ways they can be put into their cells, some of them have in consequence been broken, others have had their flint glasses turned to the object instead of to the eyepiece, and the object consequently could not be defined, 3*rdly*, some telescopes have been received without any crown glass, which had perhaps been taken out and used as a magnifier, and forgotten to be returned to its fellow flint glass Often the screwed ring is lost The only advantage I could see that this mode of securing the glass has is, that it can easily be cleaned by any one noticing how to put them together again, which in the other method is the only drawback, but seeing that all object glasses have to be cleaned after arrival from England, and very seldom, if ever, after (between the two surfaces lying together) I should prefer to have them burnished in I came to this conclusion lately for reasons above given, after I had altered all object glasses belonging to Cooke's levels from being burnished to having a screw

IV —Fixed lenses in object glasses found to be a great defect in India

7 This refers, I presume, to the construction of the glass tube only, the bubble is, no doubt, very sensitive and quite right The glass tube of which the bubble is made is ground in the inside to a long curvature If it was ground to a shorter curvature, it will not be so sensitive (fidgetty), but the accuracy of the instrument would be sacrificed A spirit bubble with a short curvature may do very well for ordinary work, but for good work they have to be discarded I can confidently say, as all instruments for the Presidency pass through my hands, that I never heard any complaint of an instrument once adjusted not standing the wear and tear In fact, I cannot see where the wear and tear is in these instruments, except in the axis and the sliding tube which moves by rack and pinion A Cooke's level once in adjustment will remain so for any number of years if not disturbed

V Bubble adjustment does not stand the test of wear and tear Its tube is observed to be not truly constructed and the bubble itself very fidgetty

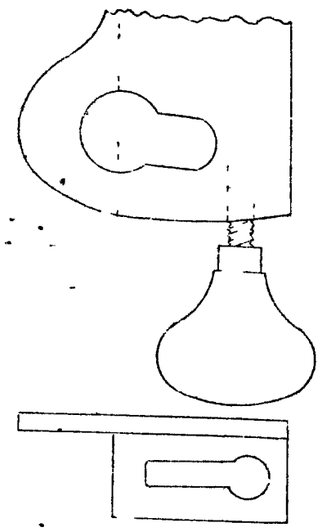
8 As I examine all instruments before despatch to the indenting officer, and never found myself nor heard from any one of any defect or deviation from the usual practice of division of the compass circle, I cannot say anything about it

VI Graduation of the compass circle contrary to the usual practice in consequence of which found inconvenient and troublesome

9 I believe that this refers to the clamping screw of the lockplate Here I certainly would propose a change The lock screw is likely to snap, or, if only a lock spring is used,

VII The clamping screw needs a collar to secure it in its place.

it may loosen itself and allow the lockplate to shift so that the levelling screws are not clamped, and by this means the instrument is liable to tumble from the stand I annex a sketch of what I propose to obviate this defect



10 I cannot see how the collination adjustment can be insecure and easily thrown out of adjustment If handled by proper surveyors, this adjustment will remain untouched as long as the spider lines (cross wires) do not want renewing I beg to propose that instead of spider lines (cross wires) a plain parallel glass with the cross lines cut on it be introduced. This will prove economical as well as efficient and save the expense oft incurred of returning instruments for the sole purpose of having new cross wires inserted

VIII Collination adjustment found to be insecure and easily thrown out.

11 The magnetic needle is generally magnetized and counterpoised by me before despatching the instrument

IX Magnetic needle in some cases found unreliable to a degree

12 Since writing the above I have personally asked the opinion of Colonel Rogers, R E, Principal of the Civil Engineering College, and that officer has assured me that the Dumpy levels by Cooke are the best he has yet seen or used, and that they are highly prized by the Masters of the College, and that he would deprecate any alteration being made in these levels Once only, says that officer, was an instrument damaged by a pupil overturning the screw Colonel Rogers, moreover, is of opinion that when once a Cooke's level is adjusted it will remain in adjustment until disarranged by tampering

13 In conclusion, I beg leave to say that, on my arrival in this country in 1861 after having attended to the wants of the Observatory, and on being retransferred to the Public Works Department, I examined all the scientific instruments in store and some belonging to the various departments, and reported thereon for the information of Government I then pointed out the inferior construction, workmanship, and materials of a large portion of the instruments in stock, and since 1862 I believe that all instruments are examined

Proceedings of the Madras Government, Public Works Department,
21st *May* 1875.

before despatch from home by a scientific officer specially appointed for that duty by the Secretary of State, and in my humble opinion the instruments supplied before 1862 can bear no comparison with the instruments subsequently received for excellent materials, superior workmanship combined with lightness and stability in construction, while every consideration appears to have been given to reduce friction to a minimum

SUBMITTED to the Chief Engineer and Secretary to Government, Public Works Department, with reference to G. O, No 1,003, dated 14th April 1875.

(Signed) R W. THOMPSON, Captain, R E,
District Engineer, Presidency.

No 394 ORDER THEREON, 21st May 1875, No 1,411.

ACCOUNT, No 10

ORDERED that a copy of these Proceedings be transmitted for the information of the Government of India with reference to their Order, Nos. 76-87 M, of the 8th March 1875.

(True Extract.)

(Signed) J O HASTED, Major, R E,
Offg Joint Secretary to Government.

No. 395 (DOCKET No 1,412, dated 21st May 1875)

COPY of the above forwarded to the Government of India.

(True Extract.)

Major, R E,
Offg Joint Secretary to Government

Exd E C Shunker
Spare Copies

Public Works Workshops
Chepauk 5th May 1875.

Recd 6-5-75

To

The General Superintendent
Public Works Stores and Workshops,
Madras.

Sir.

With reference to Colonel Strange's Memo: on the reported defects in Cooke and Sons Levelling Instruments, recorded in my G. O. 14th April 1875, No. 1003, forwarded for any remarks, I beg to say that I have not heard or received any Complaint respecting these Levels I found that Levelling Instruments by Cooke and Sons have been in use in this Presidency since 1866 in which year 64 Levelling Instruments were received and in 1871, Ninety three more were supplied by the Home Government, making in all 157, from which number 55 have been issued principally to the Public Works Department and Executive Officers invariably ask for Dumpy Levels, shewing thereby the estimation in which these Instruments are held by them, in preference to those by other Makers. I can anywhere learn

as not foreign to the subject in hand; that the Mysore D. P. W. obtained forty of Cooke's Levels from Messrs. Cox and Sons; as they were not available for supply from the Stores of the D. P. W. and very recently, the Chief Engineer Mysore preferred a Dumpy, by Cooke in the absence of 12 or 14 inch Levels in lieu, to a 20 inch Troughton's improved Y, although the latter could not be paid to be by any means a bad instrument. These are significant facts and go to show how highly Cooke's Levels are appreciated, and lately one of the Assistants employed under Mr Clarke, Drainage Engineer, assured me personally that he never had a better instrument to work with than that supplied to him from the Public Works Stores and that he could not have done the work he did in so short a time with an inferior instrument. Mr Clarke had seven of Cooke's Levels issued for the use of his Survey Establishment. I have no hesitation therefore in saying that Mr Clarke

would be a good authority to give an opinion on the goodness or otherwise of the instruments in question. In referring to Mr Clarke as an authority, I do not ignore the opinions of the Officers of the D. P. W. who, by their silence in respect to the efficiency of these instruments, their desire to have these instruments sent out of order repaired and returned to them while Levelling Establishments by Barrow notably are returned for final deposit, and their wish at all times to have Cookes Dumpy Levels in preference to others, all these facts I submit are stated admissions of the excellence of Cookes Levels and speak volumes in favor of the instruments objected to by some of the professional officers in the Presidencies and I might as fairly give it as my opinion that a better instrument than Cookes Levels for ordinary offices, superior workmanship, accuracy and efficiency were never before supplied. I do not think that Simms and Elliotts are very

good

good but I must confess that Cooke's Dumpy Levels have taken the lead since their introduction in this Presidency. Highly pleased and satisfied as I am with Cooke's Levels, there are some small defects which I would like to see remedied, and which I would very respectfully submit for the consideration of the Chief Engineer. I allude to the clamping screw of the instrument referred to in para VII. of Colonel Strange's report and which I will notice in its proper place

I will now enter per saltum on the points to noticed by Colonel Strange.

I must here quote what I have already said in my report of the 24th October 1873, viz that the improvements made by Messrs Cooke and Sons Y Levels, are 1st The axes which in former Levels rested on a base of about one inch diameter, giving friction of about 1/16 to 3/32 of an inch, are now made to revolve on a base of 2 or 2½ inches diameter, the inner part of the base having been undercurved so as to give the friction on the outer rim of the base of about ⅛ of an inch, thus giving a larger base and not more friction than in the former axes It will be apparent that an instrument revolving on such a small base as one inch, and not being in perfect counterpoise could not be made perfectly steady, especially if the instrument has been for some time in use.

The Levels made by Messrs Troughton and Simms and other Makers have six screws below the support of the Telescope to enable the instrument to be adjusted for horizontal Collimation error. This has always been considered a tedious adjustment, and by many ordinary Surveyors it has not been understood for what purpose those screws are intended. In Cookes Level this has been omitted, as that adjustment is practically made correct, and the level is consequently independent of this adjustment. The Screw foot plate and triangular base plate is another improvement on the old parallel plate

1. Want of arrangement for correcting any error in the direction of the Telescope to its vertical axes, or adjusting the horizontal axes perpendicular to the vertical

screws, as the instruments can be adjusted quicker and the screws are not so easily worn out. The stand although more cumbrous than the old pattern is infinitely more steady and trustworthy and does not get so easily out of order.

It is my belief that the allusion to definition of the Telescope which depends on achromatism of object glass, centricity of the glasses and absence of all impurities, as well as having the Telescope tube darkened I have very carefully examined Telescopes of several Levels, both of Cooke's, Troughton and Simms, Elliott Brothers, Street, Baker, and Barrow. The power of definition and Magnifying power have varied no doubt owing in some to Chromatism and eccentricity. The Telescopes of Cooke's and Troughton and Simms are about equal (Bureau of Level Telescopes of the last supply received) but by comparing Telescopes of a very old supply with those lately

II. Power of Glasses are found to be inferior to Troughton and Simms. They are not sufficiently powerful and on unfavorable weather found to be hazy in most cases.

received I find that the former are not equal in power of definition to the latter. Circumstances of this is given above, where the Chief Engineer, Bengal, after comparing a 20 inch Troughton and Simms with a 10 inch Dumpy by Cooke preferred the latter instrument.

I consider the arrangement of the adjusting screws for Level and Collimation perfect. I must observe however that the screws are often perceived so much loose, as to cause the Spring between the screw and the socket to lose its elasticity or break. I would strongly recommend that this mode of adjustment be discontinued, and the one adopted which the Levelling Instrument had when first received in this Country in 1866, as I have altered mine according to the latter arrangement.

II. Adjustment of diaphragm by means of Spiral Spring and screw, has not stood the test of wear and tear while it is affected by temperature.

IV. Tinted Lenses in Object glasses found to be a great defect in India.

But for one drawback I would prefer this method to that adopted by other Makers in fastening the Object glasses. Both means of securing the Object glass in the cell, have their benefits and draw-

but of the two methods I am of opinion that that of Lockes is the best. The drawback of the Object glasses fastened into their cells by a screwed ring are 1st although each glass is marked with notches to indicate their relative surfaces, yet they have been frequently screwed by some fool together quite promiscuously, no notice having been taken of the notches when doing so. 2ndly Taking into consideration that some of the object glasses are triplets, it can easily be imagined in how many different wrong ways they can be put into their cells, some of them have in consequence been broken, others have had their flint glasses turned to the object instead of to the eye piece, and the object consequently could not be defined. 3rdly Some Telescopes have been received without any Erect glass, which had perhaps been taken out and used as a Magnifier, and forgotten to be returned to its fellow flint glass. Often the screwed ring is lost. The only advantage I could see that this mode of securing the glass has is, that it can easily be cleaned by anyone noticing how to put them together again, which in the other method, is the only drawback: but seeing that all object glasses have to be cleaned after arrival from England, and very seldom, if ever after (between the two surfaces lying together) I should prefer to have them burnished in clause to the conclusion lately for reasons above given, after I had altered all object glasses belonging to Locke's Levels from being burnished to having a screw

1. Bubble adjustment does not stand the test of wear and tear. If tube is observed to be not truly constructed, and the bubble itself very fidgetty.

The defect I presume is the construction of the glass tube only, the bubble is, no doubt, very sensitive and quite right. The glass tube of which the bubble is made is ground in the inside to a long curvature. If it was ground to a shorter curvature it will not be so sensitive (fidgetty) but the accuracy of the instrument must be sacrificed. A Spirit bubble with a short curvature may do very well for ordinary work

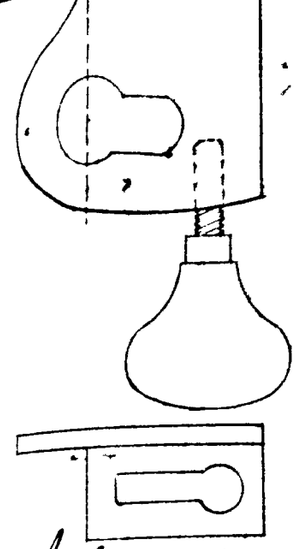
work, but for good work, they have to be discarded, I can confidently say, as all Instruments for the Presidency pass through my hands, that I never heard any complaint of an Instrument once adjusted, notstanding the wear and tear. In fact I can safely say where the wear and tear comes in these Instruments, except in the axis, and the sliding tube which merely rack and pinion. A Spirit Level once in adjustment will remain so for any number of years if not disturbed.

As I examine all Instruments before despatch to the Indenting Officer, and never send myself, nor breed from anyone of any defect or deviation from the usual practice of division of the Compass circle I cannot say anything about it

I believe that this refers to the clamping screw of the Lock plate. Here I certainly would propose a change. The lock screw is likely to crack, if only a lock spring is used

VI. Graduation of the Compass circle contrary to the usual practice in consequence of which found inconvenient and troublesome.

VII. The clamping screw needs a Collar to secure it in its place.



VIII Collimation adjustment found to be insecure and easily thrown out.

it may loosen itself and allow the Lockplate to shift so that the Levelling screws are not clamped, and by this means the Instrument is liable to tumble from the stand I annex a sketch of what I propose to obviate this defect

I cannot see how the Collimation adjustment can be made secure and easily thrown out of adjustment. If handled by proper Surveyors this adjustment will remain untouched as long as the Spider lines (Cross wires) do not wear or perish. I beg to propose that instead of Spider lines (Cross wires) a plain parallel glass with the Cross lines cut on it be introduced. This will prove economical as well as efficient, and save the expense of the time lost in returning Instruments for the sole purpose of having new Cross wires inserted.

IX Magnetic Needle in some cases found unreliable to a degree

The Magnetic Needle is generally magnetized and Counterpoised by one before despatching the Instrument.

Since writing the above I have personally asked the

opinion of Colonel Rogers R.E. Principal of the Civil Engineering College: and that Officer has assured me that the Dumpy Levels by Cooke are the best he has yet seen or used, and that they are highly prized by the Masters of the College, and that he would deprecate any alteration being made in these Levels. He only says that Officer has an Instrument damaged by a spiral overturning the screw. Colonel Rogers moreover is of opinion that when once a Cooke's Level is adjusted it will remain in adjustment until disarranged by tampering

In conclusion I beg leave to say that on my arrival in this Country in 1861 after having attended to the wants of the Observatory, and on being retransferred to the Public Works Dept I examined all the Scientific Instruments in store and some belonging to the various Departments, and reported thereon for the information of

Government. I then pointed out the inferior construction, workmanship, and materials of a large portion of the Instruments in stock, and since 1862, I believe that all Instruments are examined before despatch from Home by a Scientific Officer specially appointed for that duty by the Secretary of State, and in my humble opinion, the Instruments supplied before 1862 can bear no comparison with the Instruments subsequently received for Excellent materials, superior workmanship combined with lightness and stability in construction, while every consideration appears to have been given to reduce friction to a minimum.

I have the honor to be Sir
Your ob. Servt.
Govt. Math. Inst. Keeper

(True Copy)

J. Glaisher
Geo. Supt. Observatories &c.

Public Works Store Department
Chepauk 5 May 1875.

Read 8-5-75

No 169

From,

The General Superintendent
Public Works Stores & Workshops

To,

The District Engineer
Presidency, Fort St George

Sir,

With reference to Ly D dated 16 April 1875 No 1003, communicated with your endorsement No 345 of the 16 idem, I have the honor to submit Mr Doderets remarks on the several points noted in Colonel Strangs reply to the objections made to Messrs Cookes Levels.

2 I can bear out Mr Doderets remark that no complaints have been received in respect to these instruments. I have received no complaints, since I presumed charge

Rec'd 21 May 75
Encl 3 Sh 393

Rec'd 18/5/75